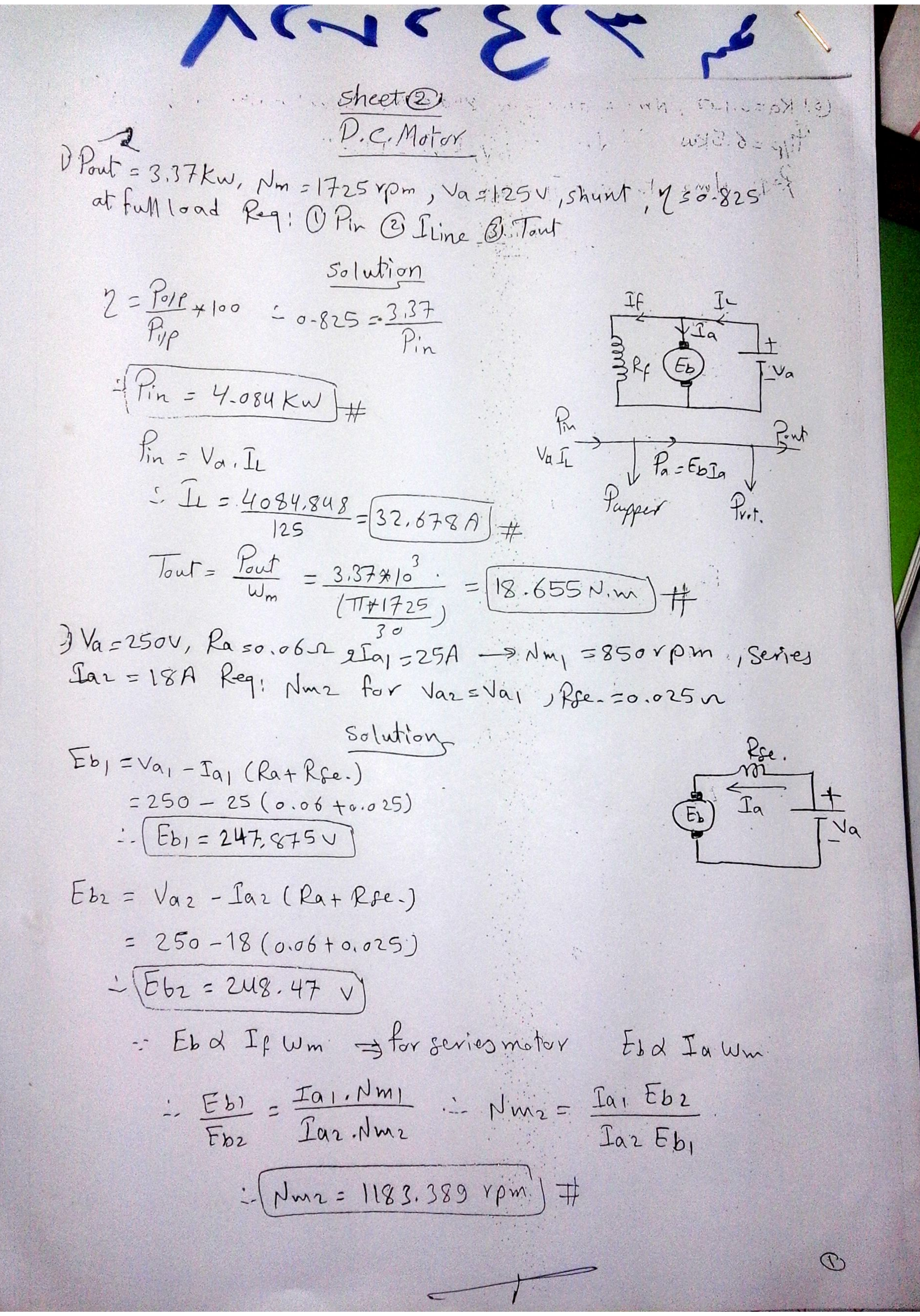


sheet (2)

D.C. Motor

1) $P_{out} = 3.37\,kW$, $N_m = 1725\,rpm$, $V_a = 125\,V$, shunt, $\eta = 0.825$ at full load. Req: (1) P_{in} (2) I_{Line} (3) T_{out}

Solution

$$\eta = \frac{P_{o/p}}{P_{i/p}} * 100 \quad \therefore 0.825 = \frac{3.37}{P_{in}}$$

$$\therefore \boxed{P_{in} = 4.084\,kW} \#$$

$$P_{in} = V_a \cdot I_L$$

$$\therefore I_L = \frac{4084.848}{125} = \boxed{32.678\,A} \#$$

$$T_{out} = \frac{P_{out}}{\omega_m} = \frac{3.37 * 10^3}{\left(\frac{\pi * 1725}{30}\right)} = \boxed{18.655\,N.m} \#$$

2) $V_a = 250\,V$, $R_a = 0.06\,\Omega$, $I_{a1} = 25\,A \rightarrow N_{m1} = 850\,rpm$, series, $I_{a2} = 18\,A$. Req: N_{m2} for $V_{a2} = V_{a1}$, $R_{se} = 0.025\,\Omega$

Solution

$$E_{b1} = V_{a1} - I_{a1}(R_a + R_{se})$$

$$= 250 - 25(0.06 + 0.025)$$

$$\therefore \boxed{E_{b1} = 247.875\,V}$$

$$E_{b2} = V_{a2} - I_{a2}(R_a + R_{se})$$

$$= 250 - 18(0.06 + 0.025)$$

$$\therefore \boxed{E_{b2} = 248.47\,V}$$

$\because E_b \propto I_f \omega_m \Rightarrow$ for series motor $E_b \propto I_a \omega_m$

$$\therefore \frac{E_{b1}}{E_{b2}} = \frac{I_{a1} \cdot N_{m1}}{I_{a2} \cdot N_{m2}} \quad \therefore N_{m2} = \frac{I_{a1}\, E_{b2}}{I_{a2}\, E_{b1}}$$

$$\therefore \boxed{N_{m2} = 1183.389\,rpm} \#$$

③ (3) $R_a = 0.1\,\Omega$, $N_{m1} = 1000\,rpm$, $250 = V_{a1}$ shunt Motor, $R_{sh1} = 250\,\Omega$

$P_{i/p} = 6.5\,kw$, if $V_{a2} = 230\,V$, $R_{sh2} = 125\,\Omega$

Req: N_{m2} to Keep T_L = cost.

Solution

at $V_{a1} = 250\,V$

$I_{a1} = I_{L1} - I_{f1}$, $I_{L1} = \frac{P_{i/p}}{V_{a1}} = 26A$

$I_{f1} = \frac{V_{a1}}{R_{sh1}} = \frac{250}{250} = 1A$

$\therefore$ $I_{a1} = 25A$

$\therefore E_{b1} = 250 - 25 * 0.1 = 247.5\,V$.

for Keeping T_L const. , $T \propto I_f I_a$

$\therefore \frac{T_{L1}}{T_{L2}} = \frac{I_{a1} I_{f1}}{I_{a2} I_{f2}} = 1$

$I_{f2} = \frac{V_{a2}}{R_{sh2}} = \frac{230}{125} = 1.84\,A$

$\therefore I_{a2} = I_{a1} \frac{I_{f1}}{I_{f2}} = 13.587\,A$

$\therefore E_{b2} = 230 - 13.587 * 0.1 = 228.6413\,V$

$\because E_b \propto I_f \omega_m$

$\therefore N_{m2} = N_{m1} * \frac{E_{b2} I_{f1}}{E_{b1} I_{f2}}$

$\therefore N_{m2} = 502\,rpm$

I_f I_L I_a R_{sh} E_b + V_a -

السرعة قلت نتيجة الكهرتين و تيار المجال زاد

1. Series motor, $R_a = 0.1\Omega$; $R_{se} = 0.05\Omega$, $V_a = 600V$; $I_{a1} = 150A$
$N_{m1} = 3000rpm$; $N_{m2} = 2000rpm$, Req , R_{add} series with armature
To keep T_L const.

Solution

$E_{b1} = V_{a1} - I_{a1}(R_a + R_{se})$

$\therefore E_{b1} = 600 - 150(0.1 + 0.05)$

$\therefore \boxed{E_{b1} = 577.5V}$

for T_L const. , $\because T_L \propto I_a^2$ in series motor

$\therefore I_{a1} = I_{a2}$

$\therefore \frac{E_{b1}}{E_{b2}} = \frac{N_{m1}}{N_{m2}}$ $\therefore E_{b2} = E_{b1} \frac{N_{m2}}{N_{m1}}$

$\therefore \boxed{E_{b2} = 385V}$

$E_{b2} = V_a - I_{a2}(R_{add} + R_a + R_{se})$

$\therefore 385 = 600 - 150(R_{add} + 0.15)$

$\therefore 215 = 150(R_{add} + 0.15)$

$\therefore R_{add} + 0.15 = 1.433$

$\therefore \boxed{R_{add} = 0.98\Omega}$ #

(5) Series $R_a = 0.1\,\Omega$, $R_{se} = 0.1\,\Omega$, $N_m = 400$ rpm, $P_{in} = 60$ Kw at $V_{a1} = 500$

if $V_{a2} \rightarrow 400$ V, $R_{ins} = 2.5$, $T_{L2} = \frac{1}{2} T_{L1}$ find $N_{m2} = ?$

Solutions

$P_{in} = V_a \cdot I_L \quad \therefore I_{L1} = I_{a1} = \frac{P_{in}}{V_{a1}} = \frac{60000}{500} = 120A$

$E_{b1} = V_{a1} - I_{a1}(R_a + R_{se})$

$\therefore E_{b1} = 500 - 120 * 0.2$

$\therefore \boxed{E_{b1} = 476\ V}$

$\therefore R_{inserted} \therefore$ flux $\downarrow\downarrow$ $\therefore I_a \downarrow\downarrow$

$\therefore T \propto I_a^2 \quad \therefore \frac{T_{L1}}{T_{L2}} = \frac{I_{a1}^2}{I_{a2}^2}, \quad T_{L2} = \frac{1}{2} T_{L1}$

$\therefore \frac{1}{\frac{1}{2}} = \frac{I_{a1}^2}{I_{a2}^2} \quad \therefore I_{a2} = \sqrt{\frac{120^2}{2}} = \boxed{84.85A}$

$\therefore E_{b2} = V_{a2} - I_{a2}(R_a + R_{se} + R_{ins})$

$\therefore E_{b2} = 400 - 84.85(0.2 + 2.5)$

$\therefore \boxed{E_{b2} = 170.905\ V}$

$\therefore N_{m2} = N_{m1} \frac{E_{b2}\, I_{a1}}{E_{b1}\, I_{a2}}$

$\therefore \boxed{N_{m2} = 203.1127\ \text{rpm}}$ #

..., $N_{m1} = 1500$ rpm, $I_{a1} = 20A$

if $R_{sh2} = 500\Omega$ $T_{L1} = T_{L2}$ Req: (1) $N_{m2} = ?$ (2) $I_{a2} = ?$

Solutions

$E_{b1} = V_{a1} - I_{a1}R_a = 250 - 20 * 0.25$

$\therefore$ $\boxed{E_{b1} = 245V}$

$I_{f1} = \frac{250}{250} = 1A$

$I_{f2} = \frac{250}{500} = 0.5A$

$\because T_{L1} = T_{L2}$ $\therefore \frac{T_{L1}}{T_{L2}} = \frac{I_{f1} \cdot I_{a1}}{I_{f2} \cdot I_{a2}}$ $\therefore I_{a2} = I_{a1} \frac{I_{f1}}{I_{f2}} = \frac{1 * 20}{0.5}$

$\therefore$ $\boxed{I_{a2} = 40A}$

$\therefore E_{b2} = V_a - I_{a2}R_a = 250 - 40 * 0.25$

$\therefore$ $\boxed{E_{b2} = 240V}$ $\therefore N_{m2} = N_{m1} * \frac{E_{b2}\ I_{f1}}{E_{b1}\ I_{f2}} = \boxed{2938.77 \text{ rpm}}$

7) $R_a = 0.1\Omega$, $R_{sh} = 400\Omega$, $V_a = 200V$ shunt, $I_{L1} = 10A$, $P_{rot.} = 100W$
$N_m = 400$ rpm Req: (1) P_a (2) P_{out} (3) η (4) T_{out}

Solutions

$I_{f1} = \frac{V_{a1}}{R_{sh}} = \frac{200}{400} = 0.5A$

$\therefore I_{a1} = 9.5A$ $\therefore E_{b1} = 200 - 9.5 * 0.1 = 199.05V$

$\therefore P_a = E_{b1} I_{a1} = \boxed{1.891 \text{ kw}}$

$P_{in} = V_{a1} \cdot I_{L1} = 2 \text{ kw}$

$\therefore P_{out} = P_a - P_{rot.} = 1.891 - 0.1 = \boxed{1.791 \text{ kw}}$

$\therefore$ $\boxed{\eta = 89.55\%}$

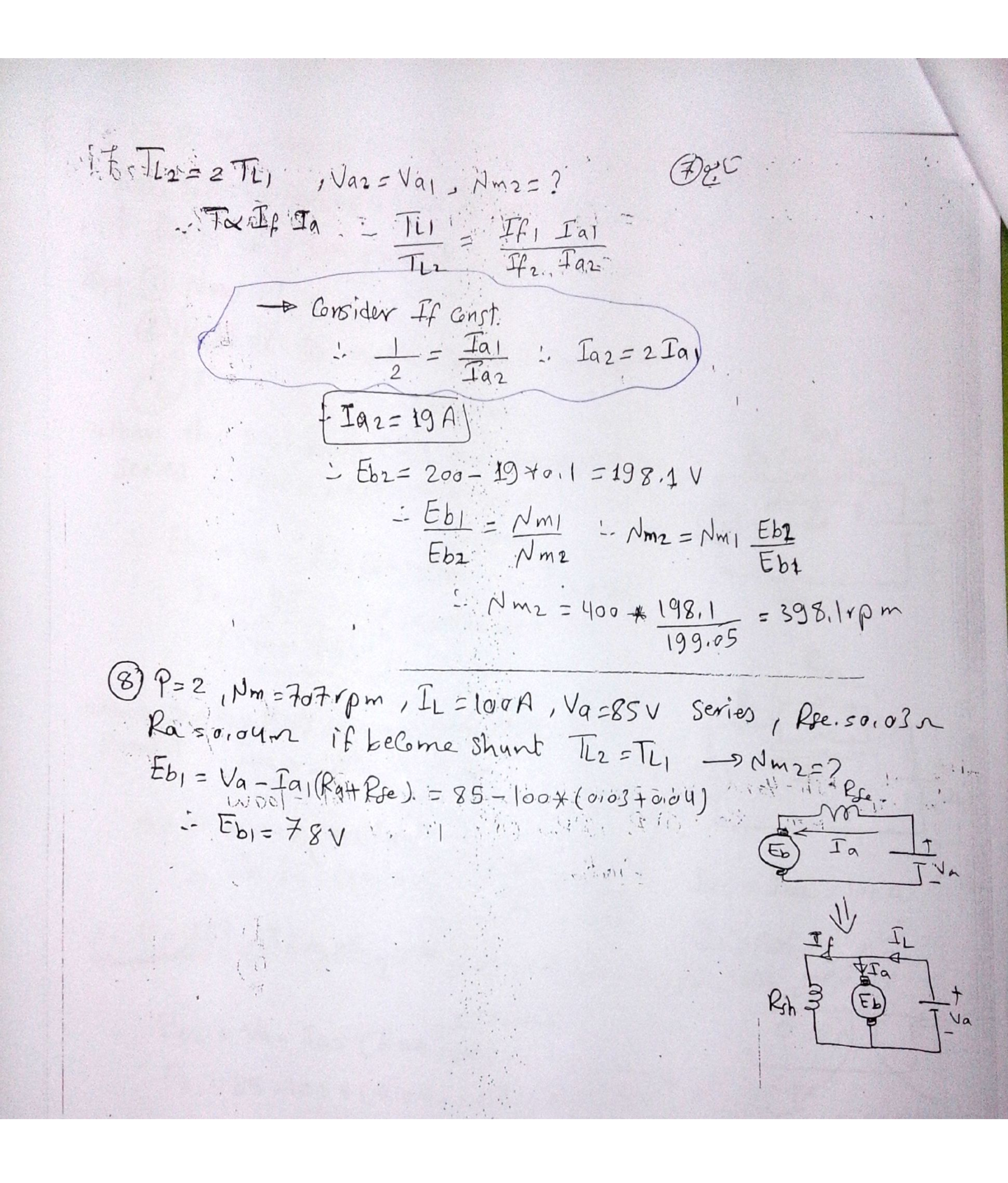
$T_{out} = \frac{P_{out}}{\omega_m} = \frac{1.791 * 10^3}{\left(\frac{\pi * 400}{30}\right)} = \boxed{42.756 \text{ N.m}}$

$\rightarrow$ if $\phi_2 = \frac{1}{2}\phi_1$ $\therefore I_{f2} = \frac{1}{2} I_{f1}$, $I_{a2} = I_{a1}$, $V_{a2} = V_{a1}$

$\therefore E_{b2} = E_{b1} = 199.05V$

$\therefore \frac{E_{b1}}{E_{b2}} = \frac{I_{f1}\ N_{m1}}{I_{f2}\ N_{m2}}$ $\therefore 1 = \frac{2 N_{m1}}{N_{m2}}$ $\therefore N_{m2} = 2N_{m1}$ #

$\therefore$ $\boxed{N_{m2} = 800 \text{ rpm}}$



$\therefore T_{L2} = 2 T_{L1}$, $V_{a2} = V_{a1}$, $N_{m2} = ?$ (7)

$\because T \propto I_f \, I_a \quad \therefore \frac{T_{L1}}{T_{L2}} = \frac{I_{f1} \, I_{a1}}{I_{f2} \, I_{a2}}$

→ Consider I_f const.

$\therefore \frac{1}{2} = \frac{I_{a1}}{I_{a2}} \quad \therefore I_{a2} = 2 I_{a1}$

$I_{a2} = 19\ A$

$\therefore E_{b2} = 200 - 19 * 0.1 = 198.1\ V$

$\therefore \frac{E_{b1}}{E_{b2}} = \frac{N_{m1}}{N_{m2}} \quad \therefore N_{m2} = N_{m1} \frac{E_{b2}}{E_{b1}}$

$\therefore N_{m2} = 400 * \frac{198.1}{199.05} = 398.1\ rpm$

---

(8) $P = 2$, $N_m = 707\ rpm$, $I_L = 100 A$, $V_a = 85 V$ series , $R_{se} = 0.03\ \Omega$

$R_a = 0.04\ \Omega$ if become shunt $T_{L2} = T_{L1} \rightarrow N_{m2} = ?$

$E_{b1} = V_a - I_{a1}(R_a + R_{se}) = 85 - 100 * (0.03 + 0.04)$

$\therefore E_{b1} = 78\ V$

1) P = 2 poles, N_{m1} = 707 rpm, I_{L1} = 100 A, V_a = 85 V with field coils in series (Two Coils), R_{se} = 0.03 Ω, R_a = 0.04 Ω, if field coils are parallel ∴ ($R_{se} = \frac{0.03}{2} = 0.015$ Ω), $T_{L1} = T_{L2}$

Req: (1) N_{m2} = ?

(2) R_{add} = ? to make speed = 707 rpm

(8) ص

Solution

When the two field coils are connected in series ∴ $R_{set} = 0.03 + 0.03 = 0.06$ Ω

$R_{se.t}$

R_a 0.03Ω 0.03Ω

I_a E_b + V_a −

Case (1)

$$\therefore E_{b1} = V_a - I_{a1}(R_a + R_{set}) \quad (R_{set} \rightarrow \text{series}), \quad I_{L1} = I_{a1}$$

$$\therefore E_{b1} = 85 - 100 * (0.04 + 0.06)$$

$$\therefore \boxed{E_{b1} = 75\text{ V}}$$

When the two field coils are connected in parallel ∴ $R_{set.(shunt)} = \frac{0.03}{2} = 0.015$ Ω

$R_{set.}$ R_a E_b I_a + V_a −

the torque is constant

$$\because T \alpha I_a^2 \text{ (series)} \quad \therefore \frac{T_1}{T_2} = \frac{I_{a1}^2}{I_{a2}^2} \quad \therefore I_{a1} = I_{a2} = 100\text{ A}$$

تيار الحمل لا يزال ثابتاً
ثم توصيل الملفات توازي لذا التيار سوف يتوزع عليهم ويتجمع مرة أخرى (العزم ثابت)

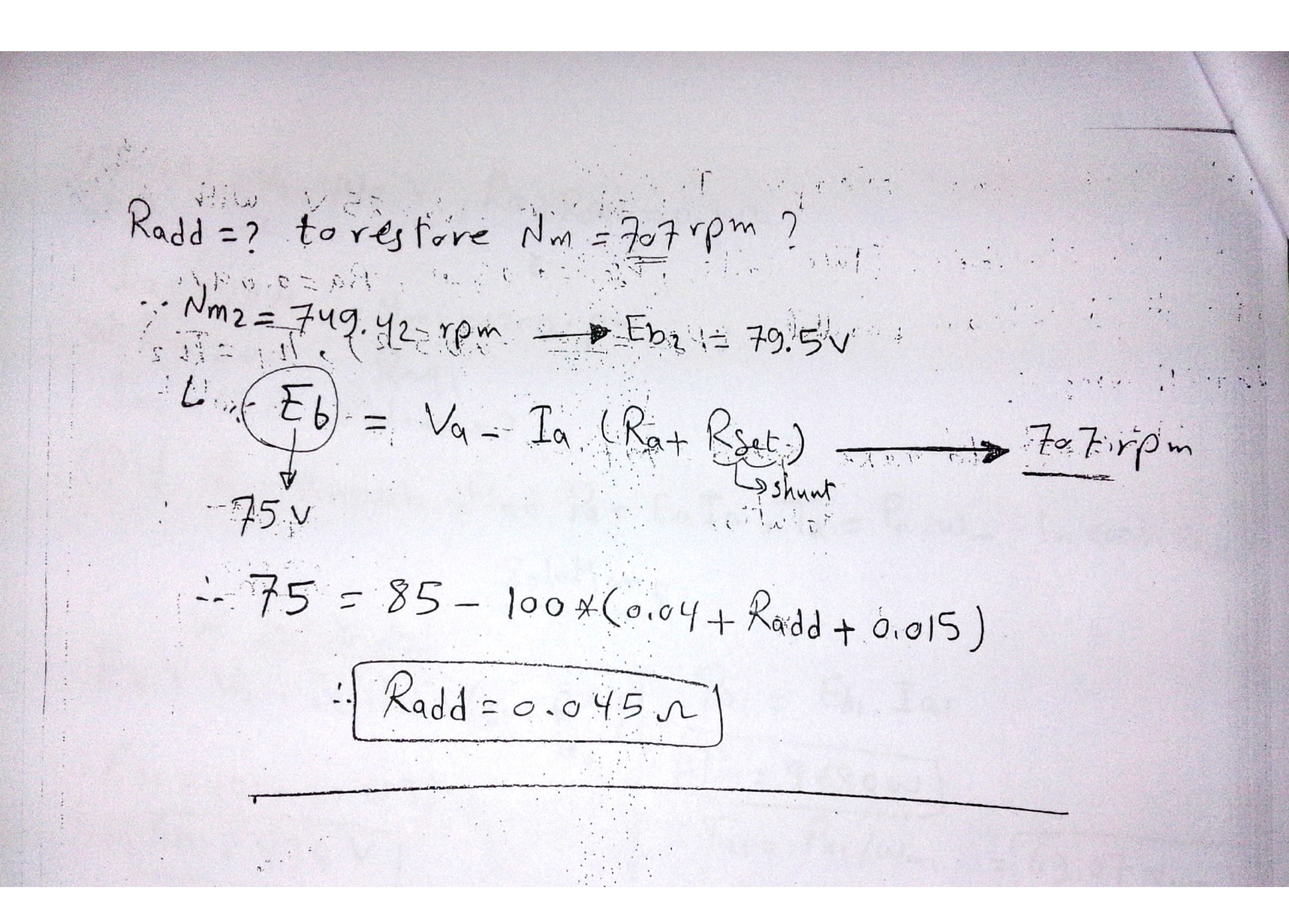
$$\therefore E_{b2} = V_a - I_{a2}(R_a + R_{set.}) \quad (R_{set.} \rightarrow \text{shunt})$$

$$\therefore E_{b2} = 85 - 100 * (0.04 + 0.015) = \boxed{79.5\text{ V}}$$

$\phi = N I$ — N: تتغير نفس الملفات ; I: ثابت (لان العزم ثابت)

$$\therefore E \alpha I_f \omega_m \quad \therefore \frac{E_{b1}}{E_{b2}} = \frac{I_{a1} N_{m1}}{I_{a2} N_{m2}} \quad \therefore N_{m2} = N_{m1}\frac{E_{b2}}{E_{b1}}$$

$$\therefore \boxed{N_{m2} = 749.42\text{ rpm}}$$



Scanned by CamScanner

1) Series, $V_a = 440\ V$, $R_a + R_{se} = 0.3\ \Omega$

at $R = 0\ \Omega$

$I_{a1} = 20\ A$, $N_{m1} = 1200\ rpm$

at $R = 3\ \Omega$

$I_{a2} = 15\ A$ ① Req1 $N_{m2} = ?$

② if $\phi_1 = 8\ mwb$, find $P_a = E_a I_a$, $T_a = P_a . \omega_m$ in each case?

Solution

at $R = 0\ \Omega$

$E_{b1} = V_a - I_{a1}(R_a + R_{se} + R)$ ($R \to 0$)

$\therefore E_{b1} = 440 - 20\ (0.3)$

$\therefore$ **$E_{b1} = 434\ V$**

at $R = 3\ \Omega$

$E_{b2} = V_a - I_{a2}(R_a + R_{se} + R)$ ($R \to 3$)

$\therefore E_{b2} = 440 - 15(0.3 + 3)$

$\therefore$ **$E_{b2} = 390.5\ V$**

$\because E_b \propto I_f\ W_m$ $\therefore E_b \propto I_a\ W_m$ (series)

$\therefore \dfrac{E_{b1}}{E_{b2}} = \dfrac{I_{f1}\ N_{m1}}{I_{f2}\ N_{m2}}$

$\therefore \dfrac{434}{390.5} = \dfrac{20 * 1200}{15 * N_{m2}}$

$\therefore$ **$N_{m2} = 1439.63\ rpm$**

$P_{a1} = E_{b1} . I_{a1}$

$\therefore$ **$P_{a1} = 8680\ W$**

$\therefore T_{a1} = P_{a1} / \omega_{m1}$ = **$69.07\ N.m$**

$P_{a2} = E_{b2} . I_{a2}$

$\therefore$ **$P_{a2} = 5857.5\ W$**

$\therefore T_{a2} = P_{a2} / \omega_{m2}$ = **$38.853\ N.m$**

19) shunt, $N_{m1} = 1200$ rpm, $V_a = 420V$, $I_{a1} = 30A$, $R_{add} = ?$

$N_{m2} = 600$ rpm, $I_{a1} = I_{a2}$, $R_a = 3\Omega$?

Solutions

$E_{b1} = V_a - I_{a1} R_a = 420 - 30 * 3 = 330V$

$\because E \propto I_f \, \omega_m$

$I_f = \text{Constant}$ لأن طريقة التحكم تتم من خلال مقاومة ال Armature $\Rightarrow I_{f1} = I_f$

$\therefore \frac{E_{b1}}{E_{b2}} = \frac{N_{m1}}{N_{m2}} = \frac{1200}{600}$ (= 2)

$\therefore E_{b1} = 2 E_{b2} \therefore E_{b2} = \frac{1}{2} E_{b1} = 165V$

$\therefore \boxed{E_{b2} = 165V}$

$\because E_{b2} = V_a - I_{a2}(R_a + R_{add})$

$\therefore 165 = 420 - 30(3 + R_{add})$

$8.5 = 3 + R_{add}$

$\therefore \boxed{R_{add} = 5.5\Omega}$